

diaphragm 8 so as to open and close the valve port 12 in a manner in which a degree of opening of the valve port 12 can be controlled. The entire vaporizer 2 is heated to a predetermined temperature by a heater (not shown in the figure) so as to promote vaporization of the liquid material by heating and prevent the material gas (vaporized liquid material) from being liquefied.

Please delete the paragraph bridging pages 3 and 4 and replace it with the following new paragraph.

Accordingly, in the vaporizing chamber 10, the vaporization of the liquid material cannot be sufficiently performed, and atomized liquid material (mist of the liquid material) may adhere to an inner wall of the vaporizing chamber 10. Most of the atomized liquid material adhering to the inner wall of the vaporizing chamber 10 is gradually vaporized since the entire vaporizer 2 is heated to a predetermined temperature. However, in many cases the liquid material is a chemically unstable material, and the liquid material may decompose due to the heat reaction before being vaporized. Thus, there is a problem of a metal component being deposited on the inner wall of the vaporizing chamber 10, which closes the openings provided in the inner wall of the vaporizing chamber 10.

Please delete the paragraph bridging pages 4 and 5 and replace it with the following new paragraph.

In order to achieve the above-mentioned objects, there is provided according to one aspect of the present invention a vaporizer which vaporizes a liquid material under a depressurized atmosphere, the vaporizer comprising: a liquid storing chamber temporarily storing the liquid material therein; a vaporizing chamber set in the depressurized atmosphere; a small aperture connecting between the liquid storing chamber and the vaporizing chamber

so as to supply the liquid material to the vaporizing chamber; a valve body which opens and closes an inlet port of the small aperture that opens the liquid storing chamber; and an actuator controlling a degree of opening of the valve body.

Page 5, delete the whole paragraph starting with line 5 and replace it with the following new paragraph.

According to the above-mentioned invention, the liquid material temporarily stored in the liquid storing chamber is supplied to the vaporizing chamber by passing through the small aperture when the valve body is moved by the actuator so as to open the inlet port of the small aperture. The vaporizing chamber is configured to define a larger space than that of the conventional vaporizer. Thus, the liquid material discharged from the outlet port of the small aperture can be efficiently atomized without adhering to the wall of the vaporizing chamber, and, thereby, the liquid material entering the vaporizing chamber can be rapidly and efficiently vaporized.

Page 8, delete the whole paragraph starting with line 22 and replace it with the following new paragraph.

A description will now be given, with reference to FIGS. 2 through 6, of a first embodiment of the present invention. FIG. 2 is a structural diagram of a semiconductor manufacturing system using a vaporizer according to the first embodiment of the present invention. FIG. 3 is a cross-sectional view of the vaporizer shown in FIG. 2. FIGS. 4, 5 and 6 are enlarged cross-sectional view of a part of the vaporizer shown in FIG. 3. FIG. 7 is a plan view of a diaphragm shown in FIG. 3. In the present embodiment, a description will be given of a case in which a copper (Cu) film is deposited by using Cu(hfac)TMVS according to the CVD method.

Page 10, delete the whole paragraph starting with line 2 and replace it with the following new paragraph.

A heater 44 such as a tape heater is wound on the material gas passage 40 on the downstream side of the vaporizer 26 so as to maintain the material gas passage 40 at a temperature ranging from, for example, 50 to 70 C, which temperature is higher than the liquidizing temperature of the film deposition gas and lower than the decomposition temperature.

Please delete the paragraph bridging pages 10 and 11 and replace it with the following new paragraph.

Additionally, a showerhead 56 is mounted on a top of the process chamber 48 so that the showerhead 56 is opposite to the table 52 and covers the entire top surface of the table 52. An end of the material gas passage 40 is connected to an inlet port of the showerhead 56 so that the film deposition gas can be showered inside the process chamber 48. A load lock chamber 60 is connected to an inner wall of the process chamber 48, which load lock chamber 60 can be set under a vacuum through a gate valve 58.

Page 12, delete the whole paragraph starting with line 3 and replace it with the following new paragraph.

The small aperture 66, which is connected to the vaporizing chamber 64, is provided on the left side of the valve body in the figure. A shallow recess 78 is provided in the vicinity of the small aperture 66. A support member 80 is attached to the vaporizer body 74 so as to cover the entire recess 78. A shallow recess 82 corresponding to the shallow recess 78 is provided to the support member 80. A disk-like diaphragm 84 is provided as a valve body 70

between the support member 80 and the vaporizer body 74 so that the diaphragm 84 sealingly separates the recess 82 of the support member 80 and the recess 78 of the vaporizer body 74 from each other. The diaphragm 84 as the valve body 70 is made of a thin stainless steel disc plate as shown in FIG. 7, and is configured to bend or deform in a direction of a thickness of the diaphragm 84 (refer to FIG. 6). The recess 78 sealed by the diaphragm 84 serves as the liquid storing chamber 62. A liquid passage 90 having a diameter of about 3 mm is formed in the vaporizer body 74 so as to connect the recess 78 to the liquid material supply passage 38.

Please delete the paragraph bridging pages 14 and 15 and replace it with the following new paragraph.

A brief description will now be given of dimensions of major parts. The diameter D1 of the outlet port 64A of the vaporizing chamber 64 ranges from about 12 mm to about 20 mm. The diameter D2 of the small aperture 66 ranges from about 0.5 mm to 2 mm, and the length L1 of the small aperture 66 is less than about 5 mm (refer to FIG. 4). In order to reduce the amount of the liquid material 30 stored in the small aperture 66, the diameter D2 and the length L1 are preferably set as small as possible so as to control the volume of the small aperture 66 within an amount of liquid material 30 corresponding to several minutes of flow. Additionally, the length L2 of the vaporizing chamber 64 is set to a value ranging from about 12 mm to about 20 mm so that a pressure loss generated by the vaporizing chamber 64 is reduced as much as possible in comparison with the diameter D1 of the outlet port 64A.

Please delete the paragraph bridging pages 15 and 16 and replace it with the following new paragraph.

The liquid material 30 such as Cu(hfac)TMVS stored in the material tank 32 of the material supply system 28 is maintained at a room temperature so as to prevent from being

decomposed. The liquid material 30 is delivered through the liquid material supply passage 38 by being pressurized by a pressurizing gas such as He gas supplied from the pressurizing pipe 36, and is introduced into the vaporizer 26 after the flow amount thereof is detected by the mass-flow meter 42 provided in the middle of the liquid material supply passage 38. A liquid flow signal generated by the mass-flow meter 42 is fed back to the valve body so as to control the flow of the liquid material 30. The liquid material 30 introduced into the vaporizer 26 is turned to a material gas by being vaporized as described later by being subjected to an adiabatic expansion in the vaporizer 26. The material gas flows through the material gas passage 40, which is heated to be a temperature higher than the meniscus point and lower than the decomposition reaction point, and is introduced into the process chamber 48 through the showerhead 56 of the process apparatus 24. The material gas is used to deposit a Cu film on the wafer W in the process chamber.

Please delete the paragraph bridging pages 16 and 17 and replace it with the following new paragraph.

A description will now be given, with reference to FIGS. 3 to 6, of an operation of the vaporizer 26. FIG. 4 shows a state in which the valve of the vaporizer 26 is full-opened. FIG. 5 shows a state in which the valve of the vaporizer 26 is half-opened. FIG. 6 shows a state in which the valve of the vaporizer 26 is completely closed. In FIG. 3, the liquid material 30 flowing through the liquid material supply passage 38 enters via the liquid passage 90 the liquid storing chamber 62, which is defined by the diaphragm 84 and has a small volume. The liquid material 30 enters the inlet port 68 and passes through the small aperture 66 when the diaphragm serving as a valve body does not seat on the inlet port 68 of the small aperture 66 and is separated from the inlet port 68, as shown in FIGS. 4 and 5. The liquid material 30 is then discharged from the outlet port 104 on the opposite end toward the